AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and/or listings of claims in the application:

1. (Cancelled)

2. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said passback direction is defined based on at least one of an image of said video monitored area and video of said video monitored area.

3. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said passback direction is user defined.

4. (Original) A computer-readable medium as in claim 3, wherein said passback direction is determined via a graphical user interface to identify said passback direction in at least one of an image of said video monitored area and video of said video monitored area.

5. (Original) A computer-readable medium as in claim 4, wherein said graphical user interface is adapted to permit a user to draw said passback direction on at least one of an image of said video monitored area and video of said video monitored area.

6. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said defining said passback direction comprises learning said passback direction through observation of said video monitored area.

7. (Original) A computer-readable medium as in claim 6, wherein said learning said passback direction comprises:

learning a normal direction for said video monitored area based on said observation of said video monitored area; and

determining said passback direction based on said normal direction.

8. (Original) A computer-readable medium as in claim 6, wherein said passback direction is learned as a function of time.

9. (Original) A computer-readable medium as in claim 8, wherein said passback direction is learned for a first time period, and wherein said defining said passback direction further comprises learning at least one additional passback direction for said video monitored area for at least one additional time period based on said observation of said video monitored area.

10. (Currently Amended) A computer-readable medium as in claim [[[1]]] 14, wherein said passback direction is defined in association with at least one of a region of interest of said video monitored area, a time interval of detection, and a sensitivity of detection.

11. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said accessing video comprises accessing video in real time from a video camera.

12. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said accessing video comprises accessing stored video.

13. (Cancelled)

14. (Currently Amended) A computer-readable medium, comprising software encoded thereon to detect passback events, which software when executed by a computer system, causes the computer system to perform operations comprising a method of as in claim 13, wherein said extracting tracks comprises:

defining a passback direction for a video monitored area;
accessing video collected from the video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from said collected video to obtain extracted foreground;

detecting trackable features based on said extracted foreground;

tracking said trackable features based on said extracted foreground to obtain extracted tracks; and

filtering said extracted tracks; ~~and~~

~~wherein said analyzing video further comprises~~ detecting passback events based on the passback direction and said extracted tracks; and

initiating an action based on the detected passback events.

15. (Original) A computer-readable medium as in claim 14, wherein said extracting foreground is based on pixel statistics of a current frame and at least one past frame.

16. (Original) A computer-readable medium as in claim 14, wherein said extracting foreground is based on three-frame motion differencing.

17. (Original) A computer-readable medium as in claim 14, wherein said detecting trackable features comprises:

subdividing foreground of said collected video into cells;

determining if each cell is appropriate for tracking; and

designating appropriate cells for tracking as trackable features.

18. (Currently Amended) A computer-readable medium as in claim 17, wherein said determining if each cell is appropriate for tracking is based on at least one of texture in each cell, intensity range in each cell, number of different intensity values in each cell, presence of at least one edge in each cell, ~~and~~ or presence of at least one corner in each cell.

19. (Original) A computer-readable medium as in claim 14, wherein said tracking said trackable features comprises:

correlating each trackable feature with previous tracked features to obtain correlated trackable features and correlated previous tracked features;

comparing directions of said correlated trackable features and said correlated previous tracked features;

designating said correlated trackable features as tracked features if said directions are consistent; and

updating said correlated previous tracked features with said correlated trackable features if said directions are consistent; and

wherein said filtering said extracted tracks comprises filtering said tracked features.

20. (Original) A computer-readable medium as in claim 19, wherein said correlating each trackable feature comprises performing two-dimensional correlation in an area predicted from said previous tracked features to contain said trackable feature.

21. (Original) A computer-readable medium as in claim 19, wherein said correlating each trackable feature comprises performing one-dimensional correlation on a horizontal projection and a vertical projection of an area predicted from said previous tracked features to contain said trackable feature.

22. (Currently Amended) A computer-readable medium as in claim 19, wherein said updating said correlated previous tracked features is based on at least one of a direction and or an age of said correlated trackable features.

23. (Currently Amended) A computer-readable medium as in claim 14, wherein said filtering said extracted tracks comprises at least one of filtering noise from said extracted tracks, filtering out nuisance extracted tracks from said extracted tracks, filtering out extracted tracks from said extracted tracks that are not sufficiently long lived, and or filtering out extracted tracks from said extracted tracks that are inconsistent with other nearby extracted tracks.

24. (Currently Amended) A computer-readable medium, comprising software encoded thereon to detect passback events, which software when executed by a computer system, causes the computer system to perform operations comprising a method of ~~as in claim 13, wherein said extracting tracks comprises~~:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from said collected video to obtain extracted foreground;

determining optical flow based on said extracted foreground to obtain said extracted tracks; and

filtering said extracted tracks;

detecting passback events based on the passback direction and the extracted tracks; and

initiating an action based on the detected passback events.

25. (Original) A computer-readable medium as in claim 24, wherein said extracting foreground is based on pixel statistics of a current frame and at least one past frame.

26. (Original) A computer-readable medium as in claim 24, wherein said extracting foreground is based on three-frame motion differencing.

27. (Original) A computer-readable medium as in claim 24, wherein said determining optical flow comprises:

determining current flow vectors for foreground pixels of said extracted foreground;

comparing current and previous flow vectors to obtain consistent current flow vectors; and

aggregating consistent current flow vectors into cumulative flow vectors.

28. (Original) A computer-readable medium as in claim 24, wherein said filtering said extracted tracks comprises at least one of filtering noise from said extracted tracks, filtering out nuisance extracted tracks from said extracted tracks, filtering out extracted tracks from said extracted

tracks that are not sufficiently long lived, and filtering out extracted tracks from said extracted tracks that are inconsistent with other nearby extracted tracks.

29. (Cancelled)

30. (Currently Amended) A computer-readable medium, comprising software encoded thereon to detect passback events, which software when executed by a computer system, causes the computer system to perform operations comprising a method of as in claim 29, wherein said comparing said track and said passback direction comprises:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

comparing a track determined from the collected video to the passback direction to detect whether any passback event occurred, comprising:

representing said track as a track vector;

representing said passback direction as a passback direction vector;

determining a dot product of said track vector and said passback direction vector; [[and]]

comparing said dot product to a threshold to determine whether said track vector is substantially aligned with said passback direction; and

when said track vector is substantially aligned with said passback direction, filtering said track vector by at least one of spatial filtering and or temporal filtering to determine whether a sufficient number of track vectors are substantially aligned with said passback direction;

detecting passback events based on the determination; and

initiating an action based on the detected passback events.

31. (Cancelled)

32. (Currently Amended) A computer-readable medium, comprising software encoded thereon to detect passback events, which software when executed by a computer system, causes the computer system to perform operations comprising a method of ~~as in claim 31~~:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

analyzing the collected video;

detecting passback events in the analyzed video based on the passback direction; and

generating a report for each detected passback event, wherein said report comprises at least one of a time of each detected passback event, a date of each detected passback event, a direction of each detected passback event, a location of each detected passback event, a size of a crossing area of each detected passback event, an indication of occlusion of each detected passback event, at least one snapshot of each detected passback event, at least one video of each detected passback event, a number of detected passback events over a time interval, ~~and~~ or a time histogram of detected passback events over a time interval.

33. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein ~~said~~ initiating said action comprises initiating a triggered response for each detected passback event.

34. (Currently Amended) A computer-readable medium as in claim 33, wherein said triggered response comprises at least one of initiating an alarm, controlling an audible alarm system, controlling a silent alarm system, accessing an alerting device, accessing an alerting system, sending an alert, logging alert data to a database, taking a snapshot of each detected passback event, culling a snapshot of each detected passback event from said video, recording video of each detected passback event, controlling a camera to zoom in on each detected passback event, controlling a camera to track each detected passback event, performing recognition of each detected passback event, closing at least one door, ~~and~~ or controlling an access control system to at least one of lock, unlock, open, and close at least one portal.

35. (Currently Amended) A computer-readable medium as in claim [[1]] 14, said method further comprising defining at least one of an option for reporting any detected passback event and or an option for responding to any detected passback event.

36. (Currently Amended) A computer-readable medium as in claim [[1]] 14, wherein said method is adapted to detect passback events in real time.

37. (Currently Amended) A method to detect passback events comprising:

defining a passback direction for a video monitored area;

accessing video collected from said video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from the collected video to obtain extracted foreground,

detecting trackable features based on the extracted foreground,

tracking the trackable features based on the extracted foreground to obtain extracted tracks, and

filtering the extracted tracks;

detecting analyzing said video collected from said video monitored area to detect any passback events in said video monitored area based on said passback direction and extracted tracks; and

initiating an action based on [[any]] the detected passback events.

38. (Currently Amended) A system to detect passback events, comprising:

at least one video camera to monitor at least one video monitored area and to obtain video of said video monitored area;

an analysis system coupled to said video camera, said analysis system comprising a computer system and a computer-readable medium, said computer-readable medium comprising software to control said computer system according to a method, said method comprising:

extracting foreground from the collected video to obtain extracted foreground,

detecting trackable features based on the extracted foreground,

tracking the trackable features based on the extracted foreground to obtain extracted tracks, and

filtering the extracted tracks to detect passback events in said video monitored area based on a passback direction and the extracted tracks for said video monitored area; and

a user interface coupled to said analysis system.

39. (Currently Amended) An apparatus to detect passback events adapted to perform operations comprising a method of:

defining a passback direction for a video monitored area;

accessing video collected from said video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from the collected video to obtain extracted foreground,

detecting trackable features based on the extracted foreground,

tracking the trackable features based on the extracted foreground to obtain extracted tracks, and

filtering the extracted tracks;

detecting ~~analyzing said video collected from said video monitored area to detect any~~ passback events in said video monitored area based on said passback direction and extracted tracks; and

initiating an action based on [[any]] the detected passback events.

40. (Currently Amended) The apparatus of claim 39, wherein said apparatus comprises application-specific hardware to emulate at least one of a computer ~~and/or~~ or software adapted to perform said operations ~~defining, said accessing, said analyzing, and said initiating~~.

41. (New) A method to detect passback events, comprising:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from the collected video to obtain extracted foreground,

determining optical flow based on the extracted foreground to obtain the extracted tracks, and

filtering the extracted tracks;

detecting passback events based on the passback direction and the extracted tracks; and

initiating an action based on the detected passback events.

42. (New) A method to detect passback events, comprising:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

comparing a track determined from the collected video to the passback direction to detect whether any passback event occurred, comprising:

representing the track as a track vector,

representing the passback direction as a passback direction vector,

determining a dot product of the track vector and the passback direction vector,

comparing the dot product to a threshold to determine whether the track vector is substantially aligned with the passback direction, and

when the track vector is substantially aligned with the passback direction, filtering the track vector by at least one of spatial filtering or temporal filtering to determine whether a sufficient number of track vectors are substantially aligned with the passback direction;

detecting passback events based on the determination; and

initiating an action based on the detected passback events.

43. (New) A method to detect passback events, comprising:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

analyzing the collected video;

detecting passback events in the analyzed video based on the passback direction; and

generating a report for each detected passback event, wherein the report comprises at least one of a time of each detected passback event, a date of each detected passback event, a direction of each detected passback event, a location of each detected passback event, a size of a crossing area of each detected passback event, an indication of occlusion of each detected passback event, at least one snapshot of each detected passback event, at least one video of each detected passback event, a number of detected passback events over a time interval, or a time histogram of detected passback events over a time interval.

44. (New) A system to detect passback events, comprising:

a video camera to monitor a video monitored area and obtain video of the video monitored area;

an analysis system coupled to the video camera, the analysis system comprising a computer system and a computer-readable medium, the computer-readable medium comprising software to control the computer system according to a method, the method comprising:

extracting foreground from the obtained video to obtain extracted foreground,

determining optical flow based on the extracted foreground to obtain extracted tracks, and

filtering the extracted tracks to detect passback events in the video monitored area based on a passback direction and the extracted tracks; and

a user interface coupled to the analysis system.

45. (New) A system to detect passback events, comprising:

a video camera to monitor a video monitored area and obtain video of the video monitored area;

an analysis system coupled to the video camera, the analysis system comprising a computer system and a computer-readable medium, the computer-readable medium comprising software to control the computer system according to a method, the method comprising:

determining a track in the obtained video,

representing the track as a track vector,

representing a passback direction as a passback direction vector,

determining a dot product of the track vector and the passback direction vector,

comparing the dot product to a threshold to determine whether the track vector is substantially aligned with the passback direction,

when the track vector is substantially aligned with the passback direction, filtering the track vector by at least one of spatial filtering or temporal filtering to determine whether a substantial number of track vectors are substantially aligned with the passback direction, and

detecting the passback events in the video monitored area based on the number of track vectors which are substantially aligned with the passback direction; and

a user interface coupled to the analysis system.

46. (New) A system to detect passback events, comprising:

a video camera to monitor a video monitored area and obtain video of the video monitored area;

an analysis system coupled to the video camera, the analysis system comprising a computer system and a computer-readable medium, the computer-readable medium comprising software to control the computer system according to a method, the method comprising:

analyzing the obtained video to detect passback events in the video monitored area based on a passback direction for the video monitored area, and

generating a report for each detected passback event,

wherein the report comprises at least one of a time of each detected passback event, a date of each detected passback event, a direction of each detected passback event, a location of each detected passback event, a size of a crossing area of each detected passback event, an indication of occlusion of each detected passback event, at least one snapshot of each detected passback event, at least one video of each detected passback event, a number of detected passback events over a time interval, or a time histogram of detected passback events over a time interval; and

a user interface coupled to the analysis system.

47. (New) An apparatus to detect passback events adapted to perform operations comprising a method of:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

extracting tracks from the collected video, comprising:

extracting foreground from the collected video to obtain extracted foreground,

determining optical flow based on the extracted foreground to obtain the extracted tracks, and

filtering the extracted tracks;

detecting passback events based on the passback direction and the extracted tracks; and

initiating an action based on the detected passback events.

48. (New) An apparatus to detect passback events adapted to perform operations comprising a method of:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

comparing a track determined from the collected video to the passback direction to detect whether any passback event occurred, comprising:

representing the track as a track vector,

representing the passback direction as a passback direction vector,

determining a dot product of the track vector and the passback direction vector,

comparing the dot product to a threshold to determine whether the track vector is substantially aligned with the passback direction, and

when the track vector is substantially aligned with the passback direction, filtering the track vector by at least one of spatial filtering or temporal filtering

to determine whether a sufficient number of track vectors are substantially aligned with the passback direction;

detecting passback events based on the determination; and

initiating an action based on the detected passback events.

49. (New) An apparatus to detect passback events adapted to perform operations comprising a method of:

defining a passback direction for a video monitored area;

accessing video collected from the video monitored area;

analyzing the collected video;

detecting passback events in the analyzed video based on the passback direction; and

generating a report for each detected passback event, wherein the report comprises at least one of a time of each detected passback event, a date of each detected passback event, a direction of each detected passback event, a location of each detected passback event, a size of a crossing area of each detected passback event, an indication of occlusion of each detected passback event, at least one snapshot of each detected passback event, at least one video of each detected passback event, a number of detected passback events over a time interval, or a time histogram of detected passback events over a time interval.